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# इलैक्ट्रानिक उपस्कर में उपयोग के लिये चररोधक — सामान्य विशिष्ट

*Indian Standard*

# VARISTORS FOR USE IN ELECTRONIC EQUIPMENT — GENERIC SPECIFICATION

UDC 621·316·825 VAR : 621·38·038

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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**Price *Rs* 120.00**

Resistors Sectional Committee, LT 14

## NATIONAL FOREWORD

This Indian Standard, which is identical with IEC Pub 1051-1/QC 420000 (1991-01) 'Varistors for use in electronic equipment — Part 1 : Generic specification', issued by the International Electrotechnical Commission, was adopted by the Bureau of Indian Standards on the recommendation of the Resistors Sectional Committee and approval of the Electronics and Telecommunication Division Council.

The text of the IEC standard has been approved as suitable for publication as Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma ( , ) has been used as a decimal marker while in Indian Standards, the current practice is to use a point ( . ) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their place are listed below along with their degree of equivalence for the editions indicated:

| *International Standard* | *Corresponding Indian Standard* | *Degree of Equivalence* |
|---|---|---|
| IEC Pub QC 001001 : 1986 Basic rules of the IEC quality assessment system for electronic components (IECQ) | IS QC 001001 : 1988 Basic rules of the IEC quality assessment system for electronic components (IECQ) | Identical |
| IEC Pub QC 001002 : 1986 Rules of procedure of the IEC quality assessment system for electronic components (IECQ) | IS QC 001002 : 1988 Rules of procedure of the IEC quality assessment system for electronic components (IECQ) | Identical |
| IEC Pub 294 (1973) Measurement of the dimensions of a cylindrical component having two axial termination | IS 13554 : 1992 Measurement of the dimensions of a cylindrical component having two axial termination | Identical |

The concerned technical committee has reviewed the provisions of IEC 27-1 (1971), IEV 50, IEC 62 (1974), IEC 63 (1963), IEC 68-1 (1988), IEC 68-2-1 (1974), IEC 68-2-1A (1976), IEC 68-2-2 (1974), IEC 68-2-2A (1976), IEC 68-2-3 (1969), IEC 68-2-6 (1982), IEC 68-2-13 (1966), IEC 68-2-14 (1974), IEC 68-2-20 (1979), IEC 68-2-21 (1983), IEC 68-2-27 (1987), IEC 68-2-30 (1969), IEC 68-2-45 (1980), IEC Guide 102 (1989), IEC 191-2 (1966), IEC 195 (1965), IEC 410 (1973), IEC 617, IEC 717 (1981), ISO 3 (1973), ISO 497 (1973), and ISO 1000 (1981) referred in this adopted standard and has decided that they are acceptable for use in conjunction with this standard.

This standard is intended primarily for use under the IECQ System. A regular Indian Standard for this component may be different, identical or similar to this standard.

Only the English language text in the International Standard has been retained while adopting it in this Indian Standard.

# *Indian Standard*

# VARISTORS FOR USE IN ELECTRONIC EQUIPMENT — GENERIC SPECIFICATION

## SECTION ONE - SCOPE

### 1. Scope

This standard is applicable to varistors with symmetrical voltage-current characteristics for use in electronic equipment.

It establishes standard terms, inspection procedures and methods of test for use in sectional and detail specifications for Qualification Approval and for Quality Assessment Systems for electronic components.

## SECTION TWO - GENERAL

### 2. General

### 2.1 Related documents

IEC Publications:

| | |
|---|---|
| Publication 27-1 (1971): | Letter Symbols to be Used in Electrical Technology: Part 1: General. |
| Publication 50: | International Electrotechnical Vocabulary (IEV). |
| Publication 60-2 (1973): | High Voltage Test Techniques: Part 2: Test Procedures. |
| Publication 62 (1974): | Marking Codes for Resistors and Capacitors. |
| Publication 68: | Environmental Testing. |
| Publication 68-1 (1982): | Part 1: General. |
| Publication 68-2-1 (1974) : | Tests A: Cold. |
| 68-2-1A (1976): | First supplement. |
| Publication 68-2-2 (1974) : | Tests B: Dry Heat. |
| 68-2-2A (1976): | First supplement. |
| Publication 68-2-3 (1969): | Test Ca: Damp Heat, Steady State. |
| Publication 68-2-6 (1970): | Test Fc: Vibration (sinusoidal). |

| | |
|---|---|
| Publication 68-2-13 (1966): | Test M: Low Air Pressure. |
| Publication 68-2-14 (1974): | Test N: Change of Temperature. |
| Publication 68-2-20 (1979): | Test T: Soldering. |
| Publication 68-2-21 (1983): | Test U: Robustness of Terminations and Integral Mounting Devices.<br>Amendment No. 1 (1985) |
| Publication 68-2-27 (1972): | Test Ea: Shock. |
| Publication 68-2-29 (1968): | Test Eb: Bump. |
| Publication 68-2-30 (1980): | Test Db: Damp Heat, Cyclic (12 + 12 hour cycle). |
| Publication 68-2-45 (1980): | Test XA and Guidance: Immersion in Cleaning Solvents. |
| Publication 294 (1969): | Measurement of the Dimensions of a Cylindrical Component having Two Axial Terminations. |
| Publication 410 (1973): | Sampling Plans and Procedures for Inspection by Attributes. |
| Publication 617: | Recommended Graphical Symbols for Diagrams. |
| Publication 695-2-2 (1980): | Fire Hazard Testing. Part 2: Test Methods. Needle-Flame Test. |
| Publication 717 (1981): | Method for the Determination of the Space Required by Capacitors and Resistors with Unidirectional Terminations. |
| Publication QC 001001 (1986): | Basic Rules of the IEC Quality Assessment System for Electronic Components (IECQ). |
| Publication QC 001002 (1986): | Rules of Procedure of the IEC Quality Assessment System for Electronic Components (IECQ). |

ISO Standards:

| | |
|---|---|
| ISO 3 (1973): | Preferred Numbers - Series of Preferred Numbers. |
| ISO 497 (1973): | Guide to the Choice of Series of Preferred Numbers and of Series Containing more Rounded Values of Preferred Numbers. |
| ISO 1000 (1973): | SI Units and Recommendations for the Use of their Multiples and of Certain Other Units. |

Note. -The above references apply to the current editions, except for IEC 68 for which the referenced edition must be used.

## 2.2 Units, symbols and terminology

### 2.2.1 General

Units, graphical symbols, letter symbols and terminology shall, whenever possible be taken from the following publications:

ISO Standard 1000
IEC Publication 27
IEC Publication 617
IEC Publication 50

When further items are required they shall be derived in accordance with the principles of the documents listed above.

### 2.2.2 Type

A group of components having similar design features and the similarity of whose manufacturing techniques enables them to be grouped together either for qualification approval or for quality conformance inspection.

They are generally covered by a single detail specification.

Note. -Components described in several detail specifications may, in some cases, be considered as belonging to the same type and may therefore be grouped together for approval and quality conformance inspection.

### 2.2.3 Style

A sub-division of a type, generally based on dimensional factors.

A style may include several variants, generally of a mechanical order.

### 2.2.4 Varistor (Voltage dependent resistor, VDR) (Graphical symbol )

A component whose conductance, at a given temperature, increases rapidly with voltage. This property is expressed by either of the following formulae:

$$U = CI^{\beta} \qquad (1)$$

or

$$I = AU^{\gamma} \qquad (2)$$

where $I$: current flowing through the varistor

$U$: voltage applied across the varistor

$\beta$: current index

$\gamma$: voltage index

$A$ and $C$: constants.

### 2.2.5 Non-linearity indices

#### 1. Current index β

Starting from formula (1) of Sub-clause 2.2.4, it is defined by the formula: $\beta = \frac{I}{U} \times \frac{dU}{dI}$

For the convenience of calculation, the following formula may be used:

$$\beta = \frac{\lg (U_1/U_2)}{\lg (I_1/I_2)}$$

β is always less than 1.

#### 2. Voltage index γ

Starting from formula (2) of Sub-clause 2.2.4, it is defined by the formula: $\gamma = \frac{U}{I} \times \frac{dI}{dU}$

For the convenience of calculation, the following formula may be used:

$$\gamma = \frac{\lg (I_1/I_2)}{\lg (U_1/U_2)}$$

γ is always greater than 1.

### 2.2.6 Maximum continuous a.c. voltage

The maximum a.c. r.m.s. voltage of a substantially sinusoidal waveform (less then 5% total harmonic distortion) which can be applied to the component under continuous operating conditions at 25 °C. At temperatures greater than 25 °C the detail specification shall give full information on derating requirements.

Note. -Normally this voltage value shall be 1,1 times the supply voltage.

### 2.2.7 Maximum continuous d.c. voltage

The maximum d.c. voltage (with less than 5% ripple) which can be applied to the component under continuous operating conditions at an ambient temperature of 25 °C. At temperatures greater than 25 °C the detail specification shall give full information on derating requirements.

2.2.8 Supply voltage

The voltage by which the system is designated and to which certain operating characteristics of the system are referred.

2.2.9 Voltage (at specified current)

The voltage, at specified d.c. current used as a reference point in the component characteristic.

2.2.10 Voltage under pulse conditions

Peak value of the voltage which appears at the terminations of the varistor when a specified current pulse is applied to it.

2.2.11 Voltage at class current (protection level)

The peak voltage developed across the varistor terminations under standard atmospheric conditions when passing an 8/20 class current pulse (see 2.2.15).

2.2.12 Isolation voltage (applicable only to insulated varistors)

The maximum peak voltage which may be applied under continuous operating conditions between the varistor terminations and any conducting mounting surface.

2.2.13 Leakage current

The current passing through the varistor at the maximum d.c. voltage, and at a temperature of 25 °C or at any other specified temperature.

2.2.14 Maximum peak current

The maximum current per pulse which may be passed by a varistor at an ambient temperature of 25 °C, for a given number of pulses.

2.2.15 Class current

A peak value of current which is 1/10 of the maximum peak current for 100 pulses at two per minute for the 8/20 pulse.

2.2.16 Pulse or impulse

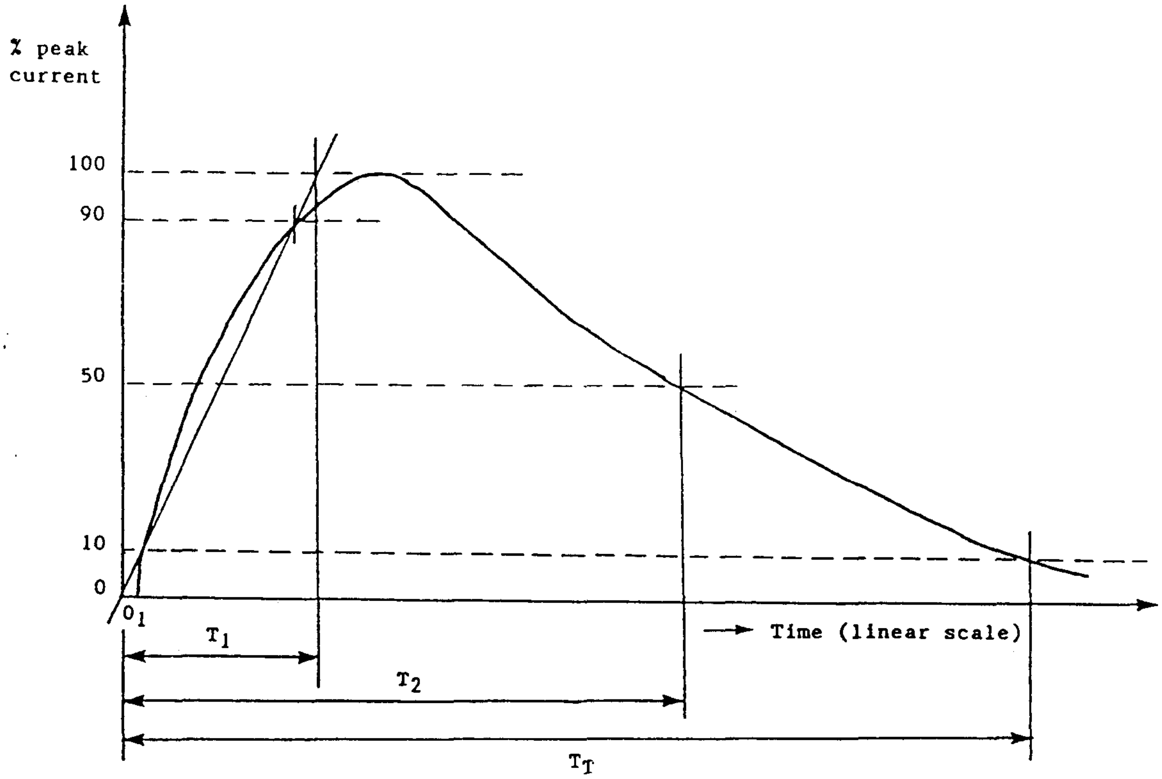
A unidirectional wave of voltage or current without appreciable oscillations.

Note. -In IEC Publication 60-2, the word "impulse" is used, however for this specification, only the word "pulse" is used.

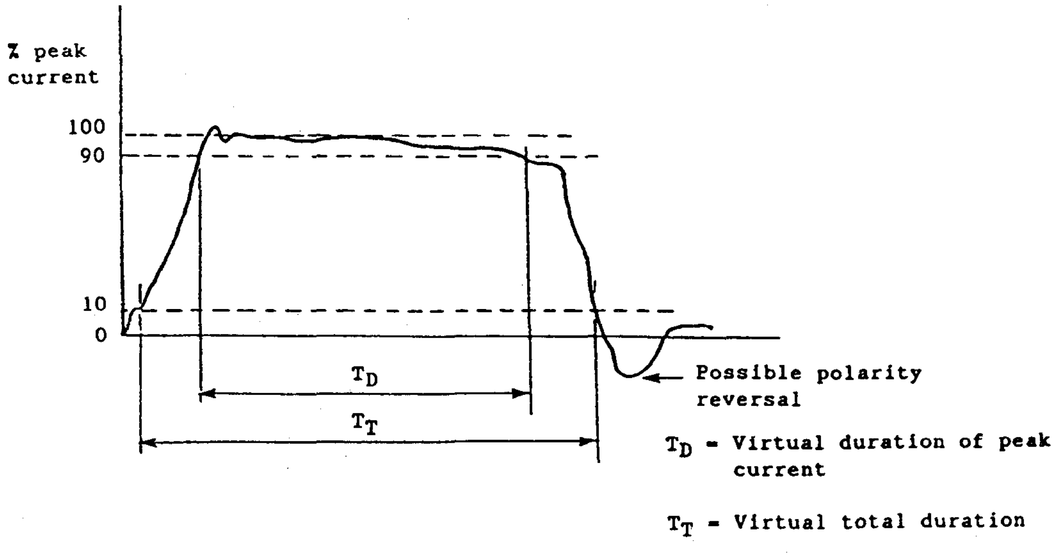
### 2.2.17 Pulse currents

Two types of pulse currents are used:

- The first type has a shape which increases from zero to a peak value in a short time, and thereafter decreases to zero either approximately exponentially or in the manner of a heavily damped sine curve. This type is defined by the virtual front time $T_1$ and the virtual time to half-value $T_2$.



- The second type has an approximately rectangular shape and is defined by the virtual duration of the peak and the virtual total duration.


% peak current
100
90
10
0
$T_D$
$T_T$
Possible polarity reversal
$T_D$ - Virtual duration of peak current
$T_T$ - Virtual total duration

### 2.2.18 Value of the pulse current

The pulse current is normally defined by its peak value. With some test circuits, overshoot or oscillations may be present on the current. The pulse current shall be defined by a smooth curve drawn through the oscillations provided the peaks of the oscillations comply with Sub-clause 4.5.2.

### 2.2.19 Virtual front time $T_1$

The virtual front time $T_1$ of a pulse current is defined as 1,25 times the interval between the instants when the pulse is 10% and 90% of its peak value. If oscillations are present on the front, the 10% and 90% values should be derived from a mean curve drawn through these oscillations provided the peaks of the oscillations are less than ± 5% of the mean curve.

### 2.2.20 Virtual origin $0_1$

The virtual origin $0_1$ of a pulse current is the instant preceding that at which the current is 10% of its peak value by a time $0,1 \times T_1$. For oscillograms having linear time sweeps, this is the intersection with the x - axis of a straight line drawn through the 10% and 90% reference points on the front.

### 2.2.21 Virtual time to half-value $T_2$

The virtual time to half-value $T_2$ of a pulse current is the time interval between the virtual origin and the instant on the tail at which the current has first decreased to half its peak value.

### 2.2.22 Virtual duration of peak of a rectangular pulse current $T_D$

The virtual duration of the peak of a rectangular pulse current is the time during which the current is greater than 90% of its peak value.

### 2.2.23 Virtual total duration $T_T$

The virtual total duration of a pulse current is the time during which the amplitude of the pulse is greater than 10% of its peak value. If oscillations are present on the front, a mean curve should be drawn in order to determine the time at which the 10% value is reached.

### 2.2.24 Category temperature range

The range of ambient temperatures for which the varistor is designed to operate continuously; this is defined by the temperature limits of its appropriate climatic category.

### 2.2.25 Upper category temperature

The maximum ambient temperature for which a varistor has been designed to operate continuously:

- either, for varistors of metal oxide construction, at that portion of the maximum continuous a.c. or d.c. voltage which is indicated in the derating curve given in the detail specification,
- or, if appropriate, for varistors of silicon carbide construction, at that portion of the rated dissipation which is indicated in the category dissipation.

### 2.2.26 Lower category temperature

The minimum ambient temperature at which a varistor has been designed to operate continuously.

### 2.2.27 Thermal resistance

The ratio between the temperature rise of the element of the varistor above the ambient temperature and the applied power.

### 2.2.28 Rated dissipation

The maximum allowable dissipation at an ambient temperature of 25 °C.

### 2.3 Preferred values

Each sectional specification shall prescribe the preferred values appropriate to the sub-family.

### 2.4 Marking

### 2.4.1 General

2.4.1.1 The information given in the marking is normally selected from the following list; the relative importance of each item is indicated by its position in the list:

a) maximum continuous a.c. voltage
b) date of manufacture
c) number of the detail specification and style reference
d) manufacturer's name or trade mark.

2.4.1.2 The varistor shall be clearly marked with a) above and with as many of the remaining items as is practicable. Any duplication of information in the marking on the varistor should be avoided.

In the case of extremely small components, the sectional specification shall prescribe the requirements.

2.4.1.3 The package containing the varistor(s) shall be clearly marked with all the information listed above.

2.4.1.4 Any additional marking shall be so applied that no confusion can arise.

### 2.4.2 Coding

When coding is used, the method shall be preferably selected from those given in IEC Publication 62.

# SECTION THREE - QUALITY ASSESSMENT PROCEDURES

## 3. Quality assessment procedures

### 3.1 Qualification Approval/Quality Assessment Systems

3.1.1 When these documents are being used for the purpose of a full quality assessment system such as the IEC Quality Assessment System for Electronic Components (IECQ), with Qualification Approval and Quality Conformance Inspection, the procedures of Sub-clauses 3.4 and 3.5 shall be complied with.

3.1.2 When these documents are used outside such quality assessment systems as the IECQ system for purposes such as design proving or type testing, the procedures and requirements of Sub-clauses 3.4.1 and 3.4.2 b) may be used, but the tests and parts of tests shall be applied in the order given in the test schedules.

### 3.2 Primary Stage of Manufacture

For varistor specifications, the primary stage of manufacture is the mixing of ingredients.

### 3.3 Structurally Similar Components

Varistors within the scope of this specification may be grouped as structurally similar for the purpose of forming inspection lots provided that the following requirements are met:

a) They shall be produced by one manufacturer on one site using essentially the same design, materials, processes and methods

b) For electrical tests, devices having the same electrical characteristics may be grouped provided that the element determining the characteristics is similar for all the devices concerned

c) For environmental tests, devices having the same encapsulation, basic internal structure and finishing processes may be grouped

d) For visual inspection (except marking) devices may be grouped if they have been made on the same production line, have the same dimensions encapsulation and external finish.

The grouping may also be used for robustness of terminations and soldering tests where it is convenient to group devices with different internal structures (see c) above.

e) For endurance tests, devices may be grouped if they have been made with the same production process in the same location using the same design and differing only in electrical characteristics. If it can be shown that one type from the group is more heavily stressed than the others then tests on this type may be accepted for the remaining members of the group.

## 3.4 * Qualification Approval Procedures

3.4.1 The manufacturer shall comply with:

- the general requirements of the rules of procedure governing qualification approval (IEC Publication QC 001002 (1986), Clause 10).
- the requirements for the primary stage of manufacture which is defined in Sub-clause 3.2 of this standard.

3.4.2 In addition to the requirements of Sub-clause 3.4.1 procedures a) or b) below shall apply:

a) The manufacturer shall produce test evidence of conformance to the specification requirements on three inspection lots for lot-by-lot inspection taken in as short a time as possible and one lot for periodic inspection. No major changes in the manufacturing process shall be made in the period during which the inspection lots are taken.

Samples shall be taken from the lots in accordance with IEC Publication 410 (see Appendix B). Normal inspection shall be used, but when the sample size would give acceptance on zero defectives, additional specimens shall be taken to meet the sample size required to give acceptance on one defective.

b) The manufacturer shall produce test evidence to show conformance to the specification requirements on the fixed sample size test schedule given in the Sectional Specification.

The specimens taken to form the sample shall be selected at random from current production or as agreed with the National Supervising Inspectorate.

3.4.3 Qualification Approval obtained as part of a Quality Assessment System shall be maintained by regular demonstration of compliance with the requirements for Quality Conformance (see Sub-clause 3.5). Otherwise this qualification approval shall be verified by the rules for the maintenance of qualification approval given in the Rules of Procedure of the IEC Quality Assessment System for Electronic Components (IEC Publication QC 001002, Sub-clauses 11.5.2 and 11.5.3.).

## 3.5 Quality Conformance Inspection

The blank detail specification(s) associated with a sectional specification shall prescribe the test schedule for Quality Conformance Inspection.

This schedule shall also specify the grouping, sampling and periodicity for the lot-by-lot and periodic inspection.

Inspection Levels and AQL's shall be selected from those given in IEC Publication 410.

If required, more than one test schedule may be specified.

### 3.5.1 Certified Records of Released Lots

When certified records of released lots are prescribed in the relevant specification and are requested by a purchaser, the following information shall be given as a minimum:

- attributes information (i.e. number of components tested and numbers of defective components) for tests in the sub-groups covered by periodic inspection without reference to the parameter for which rejection was made.
- variables information for the change in voltage or in current after the endurance test specified in the sectional specification.

### 3.5.2 Delayed delivery

Varistors held for a period exceeding two years (unless otherwise specified in the sectional specification), following the release of the lot shall, before delivery, be re-examined for visual examination, solderability and voltage at a leakage current of 1 mA as specified in Group A or B Inspection of the detail specification.

As the effect of change in voltage or current is dependent on the kind of varistor, its value and initial tolerance, the procedure adopted by the manufacturer's Chief Inspector to ensure that the voltage requirement at a leakage current of 1 mA is fulfilled, shall be approved by the National Supervising Inspectorate.

Once a "lot" has been satisfactorily re-inspected, its quality is reassured for the specified period.

### 3.5.3 Release for delivery before the completion of Group B tests

When the conditions of IEC 410 for changing to reduced inspection have been satisfied for all Group B tests, the manufacturer is permitted to release components before the completion of such tests.

### 3.6 Alternative test methods

The test and measurement methods given in the relevant specification are not necessarily the only methods which can be used. However, the manufacturer shall satisfy the National Supervising Inspectorate that any alternative methods which he may use will give results equivalent to those obtained by the methods specified. In case of dispute, for referee and reference purposes, only the specified methods shall be used.

### 3.7 Unchecked parameters

Only those parameters of a component which have been specified in a detail specification and which were subject to testing can be assumed to be within the specified limits.

It should not be assumed that any parameter not specified will remain unchanged from one component to another. Should for any reason it be necessary for (a) further parameter(s) to be controlled, then a new, more extensive, specification should be used.

The additional test method(s) shall be fully described and appropriate limits, AQL's and inspection levels specified.

# SECTION FOUR - TEST AND MEASUREMENT PROCEDURES

## 4. Test and measurement procedures

### 4.1 General

The sectional and/or blank detail specifications shall contain tables showing the tests to be made, which measurements are to be made before and after each test or sub-group of tests, and the sequence in which they shall be carried out. The stages of each test shall be carried out in the order written. The measuring conditions shall be the same for initial and final measurements.

If national specifications within any Quality Assessment System include methods other than those specified in the above documents, they shall be fully described.

The issue and amendment status of any IEC 68 test in this section is given in Sub-clause 2.1.

### 4.2 Standard atmospheric conditions

### 4.2.1 Standard atmospheric conditions for testing

Unless otherwise specified, all tests and measurements shall be made under standard atmospheric conditions for testing as given in Sub-clause 5.3 of IEC Publication 68-1:

| | |
|---|---|
| Temperature: | 15 °C - 35 °C |
| Relative humidity: | 45% - 75% |
| Air pressure: | 86 kPa - 106 kPa (860 mbar - 1 060 mbar). |

Before the measurements are made, the varistor shall be stored at the measuring temperature for a time sufficient to allow the entire varistor to reach this temperature. The same period as is prescribed for recovery at the end of a test is normally sufficient for this purpose.

When measurements are made at a temperature other than the specified temperature, the results shall, when necessary, be corrected to the specified temperature. The ambient temperature during the measurements shall be stated in the test report. In the event of a dispute, the measurements shall be repeated using one of the referee temperatures (as given in Sub-clause 4.2.3) and such other conditions as are prescribed in this specification.

When tests are conducted in a sequence, the final measurements of one test may be taken as the initial measurements for the succeeding test.

Note. -During measurements the varistor shall not be exposed to draughts, direct sun-rays or other influences likely to cause error.

### 4.2.2 Recovery conditions

Unless otherwise specified, recovery shall take place under the standard atmospheric conditions for testing (Sub-clause 4.2.1). If recovery has to be made under closely controlled conditions, the controlled recovery conditions of Sub-clause 5.4.1 of IEC 68-1 shall be used.

### 4.2.3 Referee conditions

For referee purposes one of the standard atmospheric conditions for referee tests taken from Sub-clause 5.2 of IEC Publication 68-1, as given below, shall be chosen:

| Temperature | Relative humidity | Air pressure |
|---|---|---|
| 20 ± 1 °C | 63% - 67% | 86 kPa - 106 kPa (860 mbar - 1 060 mbar) |
| 23 ± 1 °C | 48% - 52% | 86 kPa - 106 kPa (860 mbar - 1 060 mbar) |
| 25 ± 1 °C | 48% - 52% | 86 kPa - 106 kPa (860 mbar - 1 060 mbar) |
| 27 ± 1 °C | 63% - 67% | 86 kPa - 106 kPa (860 mbar - 1 060 mbar). |

### 4.2.4 Reference conditions

For reference purposes, the standard atmospheric conditions for reference given in Sub-clause 5.1 of IEC Publication 68-1 apply:

Temperature: 20 °C
Air pressure: 101,3 kPa (1 013 mbar).

## 4.3 Visual examination and check of dimensions

### 4.3.1 Visual examination

The condition, workmanship and finish shall be satisfactory as checked by visual examination.

### 4.3.2 Marking

Marking shall be legible, as checked by visual examination. It shall conform with the requirements of the detail specification.

### 4.3.3 Dimensions (gauging)

The dimensions indicated in the detail specification as being suitable for gauging shall be checked, and shall comply with the values prescribed in the detail specification.

When applicable, measurements shall be made in accordance with IEC Publication 294 or 717.

### 4.3.4 Dimensions (detail)

All dimensions prescribed in the detail specification shall be checked and they shall comply with the values prescribed.

## 4.4 Voltage or leakage current (not applicable to pulse measurements)

The varistors shall be fixed in corrosion resistant clamps by their usual means. A preferred means of mounting is given in Appendix A for measurements in air and when self-heating may occur. The method in Appendix A shall be used in case of dispute.

4.4.1 Measurement of voltage or current shall be made by using a direct voltage (or current) for as short a time as practicable, in order that the temperature of the varistor element does not rise appreciably during measurement.

Where more precise conditions of measurement are required, they shall be prescribed in the detail specification.

The measurement shall be made in two directions.

The accuracy of the measuring equipment shall be such that the error does not exceed 10% of the tolerance.

4.4.2 The measured value of voltage (or leakage current) shall comply with the limits given in the detail specification.

### 4.5 Pulse current

The varistors shall be fixed in corrosion resistant clamps by their usual means. A preferred means of mounting is given in Appendix A for measurements in air and when self-heating may occur. The method in Appendix A shall be used in case of dispute.

### 4.5.1 Standard pulse currents

Two standard pulse currents corresponding to the first type of pulse defined in Sub-clause 2.2.17 are used. One has a virtual front time of 8 µs and a time to half-value of 20 µs; it is described as an 8/20 pulse. The other has a virtual front time of 10 µs and a time to half-value of 1 000 µs; it is described as a 10/1 000 pulse.

Rectangular pulse currents, corresponding to the second type of pulse defined in Sub-clause 2.2.17 have virtual durations of the peak equal, within the specified tolerances, to 50 µs, 1 000 µs or 2 000 µs.

### 4.5.2 Tolerances

The following differences are accepted between specified values for the pulse currents and those actually recorded, provided that the measuring system meets the requirements of IEC Publication 60.

| | For 8/20 | For 10/1 000 |
|---|---|---|
| Peak value | ± 10% | ± 10% |
| Virtual front time $T_1$ | ± 10% | $^{+100}_{-10}$% |
| Virtual time to half-value $T_2$ | ± 10% | ± 20% |
| Virtual total duration | | 2,5 to 4 times $T_2$ |

A small overshoot or oscillations are tolerated provided that their single peak amplitude in the neighbourhood of the peak of the pulse is not more than 5% of the peak value. Any polarity reversal after the current has fallen to zero should not be more than 20% of the peak value.

For rectangular pulses

| | |
|---|---|
| Peak value | $^{+20}_{\ 0}\%$ |
| Virtual duration of the peak | $^{+20}_{\ 0}\%$ |

An overshoot or oscillation is tolerated provided that its peak amplitude is not more than 10% of the peak value. The total duration of a rectangular pulse should not be larger than 1,5 times the virtual duration of the peak and the polarity reversal should be limited to 10% of the peak value.

### 4.5.3 Measurement of the pulse current

The pulse current should be measured by a device which has passed the approval procedure referred to in IEC Publication 60.
The pulse shall be as defined in the detail specification.

### 4.6 Voltage under pulse condition

The varistors shall be placed in corrosion resistant clamps by their usual means. A preferred means of mounting is given in Appendix A for measurements in air and when self-heating may occur. The method in Appendix A shall be used in case of dispute.

When measurements are required of the voltages developed across the test object during tests with high pulse currents, any of the approved devices for measurement of pulse voltages listed in IEC Publication 60 may be used for the purposes.

The pulse current may induce appreciable voltages in the pulse voltage measuring circuit, causing significant errors. As a check, it is therefore recommended that the lead which normally joins the voltage divider to the live end of the test object should be disconnected from this point and connected instead to the earthed end of the test object, but maintaining approximately the same loop. Alternatively, the test object may be short-circuited or replaced by a solid metal conductor. The voltage measured under any of these conditions, when the generator is discharged, should be negligible in comparison with the voltage across the test object, at least during the part of the pulse which is of importance for evaluating the test results.

Note. -The short-circuit check may be made at a reduced current.

### 4.7 Capacitance

The varistors shall be placed in corrosion resistant clamps by their usual means. A preferred means of mounting is given in Appendix A for measurements in air and when self-heating may occur. The method in Appendix A shall be used in case of dispute.

Notes 1. -Properties of varistors depend on the frequency, arising from their capacitance. Account should be taken of this factor.

2. -Measurement of capacitance shall be made on specimens which have been allowed to recover for at least 48 hours after any other electrical test.

4.7.1 The measurements are made in normal conditions, at a frequency of 1 kHz and, unless otherwise prescribed in the detail specification, at a signal level ≤ 1 V r.m.s. with no d.c. bias.

4.7.2 The capacitance shall comply with the value given in the detail specification taking the tolerance into account.

### 4.8 Voltage proof (for insulated varistors only)

4.8.1 The test shall be conducted using one of the following three mounting methods, as prescribed in the detail specification.

### 4.8.1.1 V-block method

The varistor shall be clamped in the trough of a 90° metallic V-block of such size that the varistor body does not extend beyond the extremities of the block. The clamping force shall be such as to guarantee adequate contact between the varistor and the block. The clamping force is to be chosen in such a way that no destruction or damage to the varistor occurs. The varistor shall be positioned in accordance with the following:

- For cylindrical varistors: the varistor shall be positioned in the block so that the termination furthest from the axis of the varistor is nearest to one of the faces of the block.
- For rectangular varistors: the varistor shall be positioned in the block so that the termination nearest to the edge of the varistor is nearest to one of the faces of the block.

For cylindrical and rectangular varistors with axial leads: any out-of-centre positioning of the point of emergence of the terminations from the body shall be ignored.

### 4.8.1.2 Metal ball method

The uninsulated parts of the varistor shall be enclosed in an insulating material having a very high insulation value.

The complete varistor shall be placed in a container holding 1,6 ± 0,2 mm diameter metal balls such that only the terminations of the varistor are protruding. An electrode shall be inserted between the metal balls.

### 4.8.1.3 Foil method

A metal foil shall be wrapped closely around the body of the varistor.

For varistors not having axial terminations, a space of 1 to 1,5 mm shall be left between the edge of the foil and each termination.

For varistors having axial terminations, the foil shall be wrapped around the whole body of the varistor protruding by at least 5 mm from each end, provided that the minimum space of 1 mm between the foil and the termination can be maintained. The ends of the foil shall not be folded over the ends of the varistor.

4.8.2 The test voltage shall be applied between the terminations of the varistor connected together as one pole, and the V-block or metal foil or metal balls as the other pole. The test voltage shall be alternating (40 to 60 Hz) and shall be increased, at a rate of about 100 V/s, from zero to a peak value of 1,42 times the value of the isolation voltage specified in the detail specification. After the specified voltage has been reached the voltage shall continue to be applied for 1 min ± 5 s.

4.8.3 There shall be no breakdown or flashover.

4.9 Insulation resistance (for insulated varistors only)

4.9.1 The test shall be performed using one of the methods specified in Sub-clause 4.8.1, as prescribed in the detail specification.

4.9.2 The insulation resistance shall be measured between both terminations of the varistor connected together as one pole and the V-block, the metal balls or the metal foil, as the other pole. The measuring voltage shall be either 100 ± 15 V d.c. for varistors with an isolation voltage $< 500$ V or 500 ± 50 V d.c. for varistors with an isolation voltage $\geq 500$ V.

The voltage shall be applied for 1 min or for such shorter time as is necessary to obtain a stable reading; the insulation resistance shall be read at the end of that period.

4.9.3 The insulation resistance shall be not less than that prescribed in the detail specification.

4.10 Robustness of terminations

The varistors shall be subjected to Tests Ua$_1$, Ub, Uc and Ud of IEC Publication 68-2-21 as applicable.

4.10.1 For metal oxide varistors the voltage at specified current shall be measured as specified in Sub-clause 4.4.

4.10.2 Test Ua$_1$- Tensile

The force applied shall be:

- for terminations other than wire terminations: 20 N,
- for wire terminations see table below:

| Nominal cross-sectional area (mm$^2$) | Corresponding diameter for circular-section wires (mm) | Force (N) |
|---|---|---|
| $S \leq 0,05$ | $d \leq 0,25$ | 1 |
| $0,05 < S \leq 0,07$ | $0,25 < d \leq 0,3$ | 2,5 |
| $0,07 < S \leq 0,2$ | $0,3 < d \leq 0,5$ | 5 |
| $0,2 < S \leq 0,5$ | $0,5 < d \leq 0,8$ | 10 |
| $0,5 < S \leq 1,2$ | $0,8 < d \leq 1,25$ | 20 |
| $1,2 < S$ | $1,25 < d$ | 40 |

4.10.3 Test Ub - Bending (half of the number of terminations)

Method 1. -Two consecutive bends shall be applied in each direction. This test shall not apply if in the detail specification the terminations are described as rigid.

4.10.4 Test Uc - Torsion (other half of the number of terminations)

Method A, severity 2 (two successive rotations of 180°) shall be used.

This test shall not apply if in the detail specification the terminations are described as rigid and to components with unidirectional terminations designed for printed wiring applications.

4.10.5 Test Ud - Torque (for terminations with threaded studs or screws and for integral mounting devices)

| Nominal thread diameter (mm) | | 2,6 | 3 | 3,5 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Torque (N.m) | Severity 1 | 0,4 | 0,5 | 0,8 | 1,2 | 2,0 | 2,5 |
| | Severity 2 | 0,2 | 0,25 | 0,4 | 0,6 | 1,0 | 1,25 |

4.10.6 After recovery, the varistors shall be visually examined. There shall be no visible damage.

4.10.7 For silicon carbide varistors, the leakage current shall be measured as prescribed in Sub-clause 4.4 and the value shall not exceed that prescribed in the detail specification.

For metal oxide varistors the voltage at specified current shall be measured as prescribed in Sub-clause 4.4 and the change from the initially measured value shall not exceed the limits prescribed in the detail specification.

4.11 Solderability

4.11.1 Varistors shall be subjected to test Ta of IEC Publication 68-2-20 either using the solder bath method (Method 1) or the soldering iron method (Method 2) or the solder globule method (Method 3) as prescribed by the detail specification.

4.11.2 When the solder bath method (Method 1) is specified, the following requirements apply:

4.11.2.1 Test conditions

- No ageing

a) All varistors, except those of b) below:

Bath temperature: 235 ± 5 °C
Immersion time: 2 ± 0,5 s
Depth of immersion (from the seating plane or varistor body):

$$2 ^{+0}_{-0,5} \text{ mm}$$

using a thermal insulating screen of 1,5 ± 0,5 mm thickness.

b) Varistors indicated by the detail specification as being not designed for use on printed boards:

Depth of immersion (from the varistor body):

$$3,5\ ^{+0}_{-0,5}\ \text{mm}$$

4.11.2.2 The terminations shall be examined for good tinning as evidenced by free flowing of the solder with wetting of the terminations.

4.11.3 When the solder bath method is not applicable, the detail specification shall define the test method, test conditions and the requirements.

Note. -When the solder globule method is used, the requirement shall include the soldering time.

### 4.12 Resistance to soldering heat

4.12.1 For metal oxide varistors the voltage at specified current shall be measured as specified in Sub-clause 4.4.

4.12.2 Unless otherwise stated in the detail specification the varistors shall undergo test Tb of IEC Publication 68-2-20 with the following requirements:

a) All varistors except those of b) below:

Method 1A, with a duration of 5 s or 10 s, as specified in the detail specification.
Depth of immersion from the seating plane $2\ ^{+0}_{-0,5}$ mm,
using a thermal insulating screen of 1,5 ± 0,5 mm thickness.

b) Varistors not designed for use on printed boards as indicated by the detail specification:

Method 1B
Depth of immersion from the varistor body: $3,5\ ^{+0}_{-0,5}$ mm

4.12.3 After recovery, the varistors shall be visually examined. There shall be no visible damage and the marking shall be legible.

4.12.4 For silicon carbide varistors, the leakage current shall be measured as prescribed in Sub-clause 4.4 and the value shall not exceed that prescribed in the detail specification.

For metal oxide varistors the voltage at specified current shall be measured as prescribed in Sub-clause 4.4 and the change from the initially measured value shall not exceed the limits prescribed in the detail specification.

4.13 Rapid change of temperature

4.13.1 For metal oxide varistors the voltage at specified current shall be measured as specified in Sub-clause 4.4.

4.13.2 The varistors shall be subjected to Test Na of IEC Publication 68-2-14 for five cycles. The duration of the exposure at each of the extremes of temperature shall be 30 min.

The varistors shall then remain under standard atmospheric conditions for recovery for not less than 1 h nor more than 2 h.

4.13.3 After recovery, the varistors shall be visually examined. There shall be no visible damage and the marking shall be legible.

4.13.4 For silicon carbide varistors, the leakage current shall be measured as prescribed in Sub-clause 4.4 and the value shall not exceed that prescribed in the detail specification.

For metal oxide varistors the voltage at specified current shall be measured as prescribed in Sub-clause 4.4 and the change from the initially measured value shall not exceed the limits prescribed in the detail specification.

4.14 Bump

4.14.1 For metal oxide varistors the voltage at specified current shall be measured as specified in Sub-clause 4.4.

4.14.2 The varistor shall be mounted as indicated in the relevant specification.

4.14.3 The varistors shall be subjected to Test Eb of IEC Publication 68-2-29 using the degree of severity prescribed in the detail specification.

4.14.4 After recovery, the varistors shall be visually examined. There shall be no visible damage.

4.14.5 For silicon carbide varistors, the leakage current shall be measured as prescribed in Sub-clause 4.4 and the value shall not exceed that prescribed in the detail specification.

For metal oxide varistors the voltage at specified current shall be measured as prescribed in Sub-clause 4.4 and the change from the initially measured value shall not exceed the limits prescribed in the detail specification.

4.15 Shock

4.15.1 For metal oxide varistors the voltage at specified current shall be measured as specified in Sub-clause 4.4.

4.15.2 The varistor shall be mounted as indicated in the relevant specification.

4.15.3 The varistors shall be subjected to Test Ea of IEC Publication 68-2-27 using the degree of severity prescribed in the detail specification.

4.15.4 After recovery, the varistors shall be visually examined. There shall be no visible damage.

4.15.5 For silicon carbide varistors, the leakage current shall be measured as prescribed in Sub-clause 4.4 and the value shall not exceed that prescribed in the detail specification.

For metal oxide varistors the voltage at specified current shall be measured as prescribed in Sub-clause 4.4 and the change from the initially measured value shall not exceed the limits prescribed in the detail specification.

### 4.16 Vibration

4.16.1 For metal oxide varistors the voltage at specified current shall be measured as specified in Sub-clause 4.4.

4.16.2 The varistor shall be mounted as indicated in the relevant specification.

4.16.3 Unless otherwise prescribed by the detail specification the varistors shall be subjected to Method B4 of Test Fc of IEC Publication 68-2-6 using the degree of severity prescribed in the detail specification.

4.16.4 After recovery, the varistor shall be visually examined. There shall be no visible damage.

4.16.5 For silicon carbide varistors, the leakage current shall be measured as prescribed in Sub-clause 4.4 and the value shall not exceed that prescribed in the detail specification.

For metal oxide varistors the voltage at specified current shall be measured as prescribed in Sub-clause 4.4 and the change from the initially measured value shall not exceed the limits prescribed in the detail specification.

### 4.17 Climatic sequence

4.17.1 For metal oxide varistors the voltage at specified current shall be measured as specified in Sub-clause 4.4.

4.17.2 In the climatic sequence, an interval of maximum 3 days is permitted between any of the tests, except that the cold test shall be applied immediately after the recovery period specified for the first cycle of the damp heat, cyclic, Test Db.

#### 4.17.3 Dry heat

The varistors shall be subjected to Test Ba of IEC Publication 68-2-2 at the upper category temperature for a duration of 16 h.

#### 4.17.4 Damp heat, cyclic, Test Db, first cycle

The varistors shall be subjected to Test Db of IEC Publication 68-2-30 for one cycle of 24 h, using a temperature of 55°C (Severity b), Variant 1.

#### 4.17.5 Cold

The varistors shall be subjected to Test Aa of IEC Publication 68-2-1 at the lower category temperature for a duration of 2 h.

4.17.6 Low air pressure

a) The varistors shall be subjected to Test M of IEC Publication 68-2-13 using the degree of severity prescribed in the detail specification.

b) The test shall be carried out at a temperature of between 15 °C and 35 °C.
The duration of the test shall be 1 h.

4.17.7 Damp heat, cyclic, Test Db, remaining cycles

The varistors shall be subjected to Test Db of IEC Publication 68-2-30 for the following cycles of 24 h as indicated in the table below, at a temperature of 55 °C (Severity b), Variant 1.

| Categories | Number of cycles |
|---|---|
| -/-/56 | 5 |
| -/-/21 | 1 |
| -/-/10 | 1 |
| -/-/04 | 0 |
| -/-/00 | 0 |

4.17.8 The varistors shall remain under standard atmospheric conditions for recovery for not less than 1 h nor more than 2 h.

4.17.9 After recovery the varistors shall be visually examined. There shall be no visible damage and the marking shall be legible.

4.17.10 For silicon carbide varistors, the leakage current shall be measured as prescribed in Sub-clause 4.4 and the value shall not exceed that prescribed in the detail specification.

For metal oxide varistors the voltage at specified current shall be measured as prescribed in Sub-clause 4.4 and the change from the initially measured value shall not exceed the limits prescribed in the detail specification.

4.17.11 The insulation resistance shall be not less than that prescribed in the detail specification.

4.17.12 The voltage proof test shall be performed as prescribed in Sub-clause 4.8. There shall be no breakdown or flashover.

4.18 Damp heat, steady state

4.18.1 For metal oxide varistors the voltage at specified current shall be measured as specified in Sub-clause 4.4.

4.18.2 The varistors shall be subjected to Test Ca of IEC Publication 68-2-3 using the degree of severity corresponding to the climatic category of the varistor as indicated in the detail specification.

4.18.2.1 The varistors shall be divided into two groups:

a) The first group shall be subjected to this test without voltage applied.

b) The second group shall be subjected to the test and a d.c. voltage as prescribed in the sectional or in the detail specification shall be applied.

4.18.3 The varistors shall remain under standard atmospheric conditions for recovery for not less than 1 h nor more than 2 h.

4.18.4 After recovery, the varistors shall be visually examined. There shall be no visible damage and the marking shall be legible.

4.18.5 For silicon carbide varistors, the leakage current shall be measured as prescribed in Sub-clause 4.4 and the value shall not exceed that prescribed in the detail specification.

For metal oxide varistors the voltage at specified current shall be measured as prescribed in Sub-clause 4.4 and the change from the initially measured value shall not exceed the limits prescribed in the detail specification.

4.18.6 The insulation resistance shall be not less than that prescribed in the detail specification.

### 4.19 Fire hazard

The varistors shall be subjected to the needle flame test of IEC Publication 695-2-2.

The detail specification shall specify the following details:

a) any preconditioning, if required

b) the number of test specimens, if not three

c) the position of the specimen

d) the surface to be tested and the point of application

e) the underlying layer to be used to evaluate the effect of flaming drops

f) The level of severity:
   - the duration of application of the test flame ($t_a$)

g) the requirements:
   - the permissible duration and extent of burning, considering the design and the arrangements of the various parts, and shields and barriers inside the equipment

   - whether the criteria specified are sufficient to check compliance with the safety requirements, or whether further criteria should be introduced

h) any deterioration of mechanical/electrical properties allowed.

4.20 Endurance at upper category temperature

4.20.1 For metal oxide varistors the voltage at specified current shall be measured as specified in Sub-clause 4.4.

4.20.2 The varistors shall be subjected to an endurance test of 1 000 ± 24 h at an ambient temperature equal to the upper category temperature specified in the detail specification.

4.20.3 The maximum continuous d.c. or a.c. voltage, as prescribed in the detail specification, and taking account of the derating curve, shall be applied in cycles of 1,5 h on and 0,5 h off throughout the test in accordance with the operating conditions appropriate to the upper category temperature.

The half-hour off periods are included in the total duration specified in Sub-clause 4.20.1.

4.20.4 The varistors shall be held in position by their terminations to suitable clips on a rack of insulating material.

The distance between two adjacent varistors shall be not less than three times the major dimension of their body.

There shall be no undue draught over the varistors. Only natural convection resulting from the hot varistors is allowed.

4.20.5 After approximately 48 h, 500 h and 1 000 h the varistors shall be removed from the chamber and allowed to cool under standard atmospheric conditions for recovery of 4 ± 0,5 h.

The removal from the chamber shall take place at the end of an half-hour off-period.

4.20.5.1 After recovery, the varistors shall be visually examined. There shall be no visible damage and the marking shall remain legible.

4.20.5.2 For silicon carbide varistors, the leakage current shall be measured as prescribed in Sub-clause 4.4 and the value shall not exceed that prescribed in the detail specification.

For metal oxide varistors the voltage at specified current shall be measured as prescribed in Sub-clause 4.4 and the change from the initially measured value shall not exceed the limits prescribed in the detail specification.

4.20.6 After intermediate measurements, the varistors shall be returned to the test chamber. The interval between the removal of any varistor from the chamber and its return to the conditions of test shall not exceed 12 h.

4.20.7 After 1 000 h the varistor shall additionally be subjected to the following tests.

4.20.7.1 The voltage at class current shall be measured and the value shall not exceed that prescribed in the detail specification.

4.20.7.2 The insulation resistance shall be measured and the value shall be not less than that prescribed in the detail specification.

### 4.21 Solvent resistance of marking

4.21.1 The components shall be subjected to Test XA of IEC Publication 68-2-45 with the following details:

| | |
|---|---|
| a) Solvent to be used: | See Sub-clause 3.1.1 of IEC Publication 68-2-45. |
| b) Solvent temperature: | 23 ± 5 °C. |
| c) Conditioning: | Method 1 (with rubbing). |
| d) Rubbing material: | Cotton wool. |
| e) Recovery time: | Not applicable, unless otherwise stated in the detail specification. |

4.21.2 After the test the marking shall be legible.

### 4.22 Component solvent resistance

### 4.22.1 Initial measurements

The measurments prescribed in the relevant specification shall be made.

4.22.2 The components shall be subjected to Test XA of IEC Publication 68-2-45 with the following details:

| | |
|---|---|
| a) Solvent to be used: 68-2-45. | See Sub-clause 3.1.1 of IEC Publication |
| b) Solvent temperature: | 23 ± 5 °C, unless otherwise specified in the detail specification. |
| c) Conditioning: | Method 2 (without rubbing). |
| e) Recovery time: | 48 h, unless otherwise stated in the detail specification. |

4.22.3 The measurements prescribed in the relevant specification shall be made and the specified requirements shall be met.

## APPENDIX A

## MOUNTING FOR MEASUREMENTS OF VARISTORS

Varistors with leads shall be connected (but not soldered) to phosphor-bronze wires of 1,3 mm ± 10% diameter, mounted on a base of insulation material, as shown below.

Dimensions in millimetres

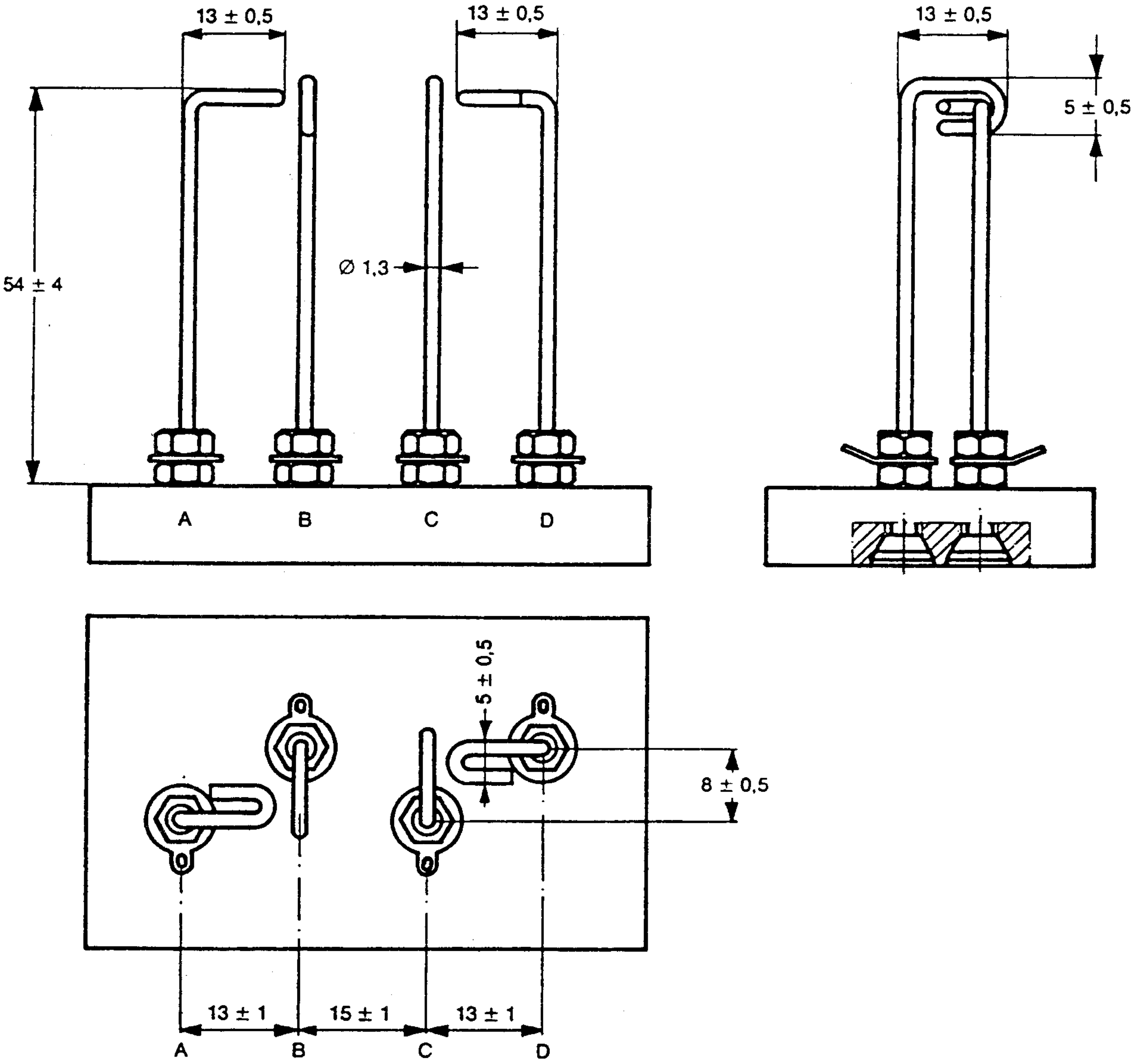


Figure 3

Note. -Unless otherwise specified in the detail specification, the components shall be connected at a distance of 6 ± 1 mm from the body.

## APPENDIX B

## INTERPRETATION OF SAMPLING PLANS AND PROCEDURES AS DESCRIBED IN IEC PUBLICATION 410 FOR USE WITHIN THE IEC QUALITY ASSESSMENT SYSTEM FOR ELECTRONIC COMPONENTS

When using IEC 410 for inspection by attributes the following interpretations of the clauses and sub-clauses indicated below apply for the purpose of this standard:

1.1 The responsible authority is the National Authorized Institution implementing the Basic Rules and Rules of Procedure.

1.5 The unit of product is the electronic component defined in a detail specification.

2 Only the following definitions from this clause are required:

- a defect is any non-conformance of the unit of product to specified requirements
- a defective is a unit of product which contains one or more defects.

3.1 The extent of non-conformance of a product shall be expressed in terms of per cent defective.

3.3 Not applicable.

4.5 The responsible authority is the IEC Technical Committee drafting the blank detail specification which forms part of the generic or sectional specification.

5.4 The responsible authority is the Chief Inspector, acting in accordance with the procedures prescribed in the document describing the inspection department of the approved manufacturer and approved by the National Supervising Inspectorate.

6.2 The responsible authority is the Chief Inspector.

6.3 Not applicable.

6.4 The responsible authority is the Chief Inspector.

8.1 Normal inspection shall always be used at the start of inspection.

8.3.3(d) The responsible authority is the Chief Inspector.

8.4 The responsible authority in the National Supervising Inspectorate.

9.2 The responsible authority is the IEC Technical Committee drafting the blank detail specification which forms part of the generic or sectional specification.

9.4 (Fourth sentence only). Not applicable.
(Fifth sentence only). The responsible authority is the Chief Inspector.

10.2 Not applicable.

# APPENDIX C

## RULES FOR THE PREPARATION OF DETAIL SPECIFICATIONS FOR CAPACITORS AND RESISTORS FOR ELECTRONIC EQUIPMENT

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1. The drafting of a complete detail specification by IEC Technical Committee No. 40: Capacitors and Resistors for Electronic Equipment, if required, shall begin only when all the following conditions have been met:

   a) the generic specification has been approved;

   b) the sectional specification, when appropriate, has been circulated for approval under the Six Months' Rule;

   c) the associated blank detail specification has been circulated for approval under the Six Months' Rule;

   d) there is evidence that at least three National Committees have formally approved as their own national standard, specifications covering a component of closely similar performance.

   Where a National Committee formally asserts that substantial or significant use is made within its country of a part described by some other national standard, this assertion may count towards the foregoing requirement.

2. Detail specifications prepared under the responsibility of Technical Committee No. 40, shall use the standard or preferred values, ratings and characteristics and severities for environmental tests, etc., which are given in the appropriate generic or sectional specifications.

   An exception to this rule may only be granted for a specific detail specification, when agreed by Technical Committee No. 40.

3. The detail specification should not be circulated under the Six Months' Rule until the sectional and blank detail specifications have been approved for publication.